THE ROCKY MOUNTAIN ALPINE TYPE

RANGE CONDITIONS, TRENDS AND LAND USE

(A Preliminary Report)

By

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U.S. DEPT. OF AGRICULTURE

FOREST SERVICE

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-April, 1951-

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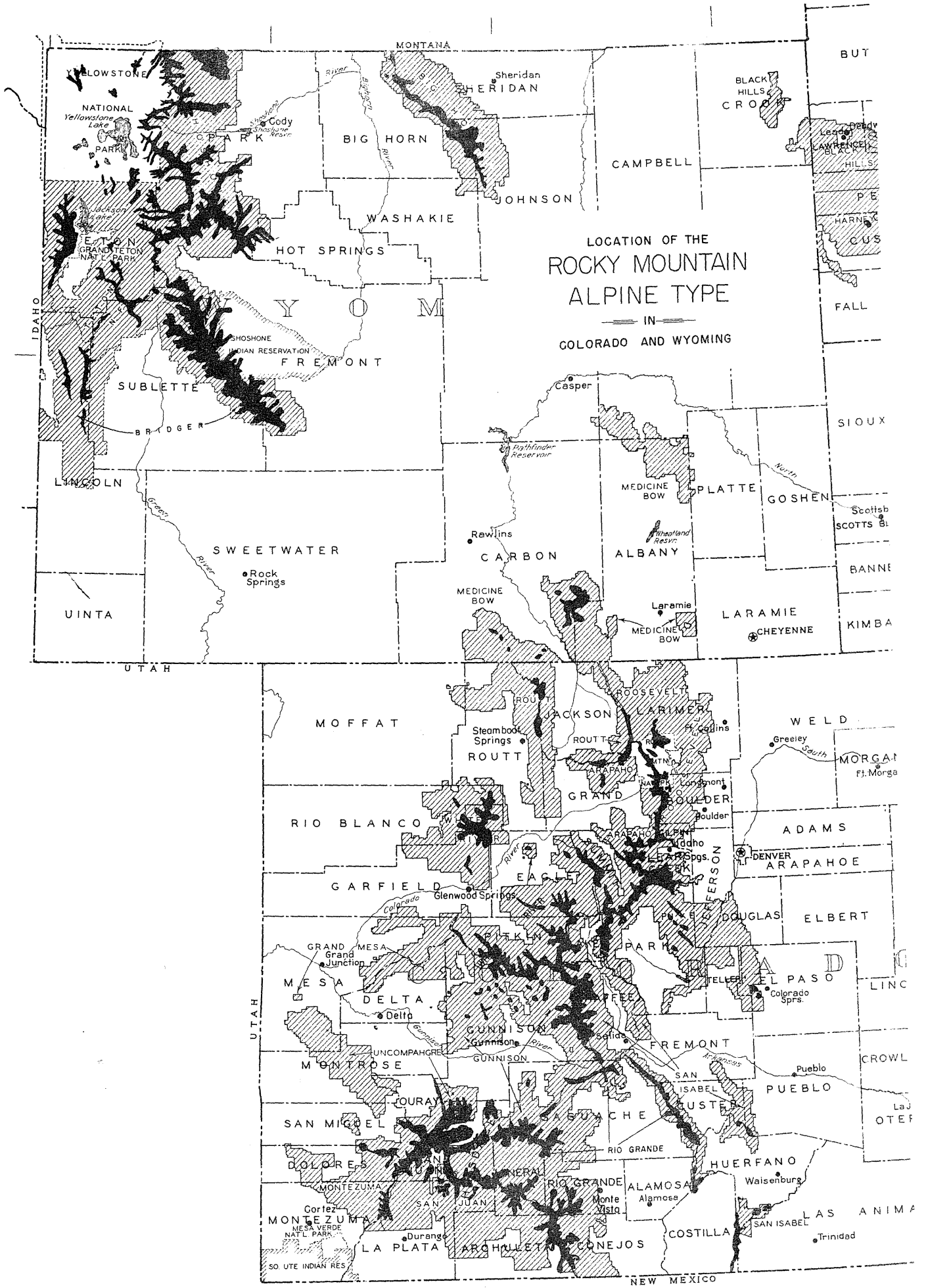
LOCATION OF THE
ROCKY MOUNTAIN
ALPINE TYPE
IN
COLORADO AND WYOMING
MONTANA
IDAHO
UTAH
NEW MEXICO
YELLOWSTONE NATIONAL Yellowstone Lake PARK
PARK
BIG HORN
HOT SPRINGS
WASHAKIE
TETON GRAND TETON NAT'L PARK
Jackson Lake
SHOSHONE INDIAN RESERVATION
FREMONT
SUBLETTE
BRIDGER
LINCOLN
SWEETWATER
UINTA
Rock Springs
Rawlins
CARBON
MEDICINE BOW
ALBANY
LARAMIE
Laramie
CHEYENNE
Casper
Pathfinder Reservoir
PLATTE
GOSHEN
SIOUX
Wheatland Resvr.
Sheridan
SHERIDAN
JOHNSON
CAMPBELL
CROOK
BLACK HILLS
Cody
MOFFAT
Steamboat Springs
ROUTT
JACKSON
ROOSEVELT
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Ft. Collins
Greeley
WELD
MORGAN
Ft. Morgan
GRAND
BOULDER
Boulder
RIO BLANCO
ADAMS
Idaho Springs
DENVER
ARAPAHOE
GARFIELD
Glenwood Springs
EAGLE
PITKIN
PARK
DOUGLAS
ELBERT
GRAND MESA
Grand Junction
MESA
DELTA
Delta
TELLER
EL PASO
Colorado Sprs.
GUNNISON
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Salida
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MONTROSE
UNCOMPAHGRE
SAN ISABEL
Pueblo
PUEBLO
OURAY
CUSTER
SAN MIGUEL
LA GARITA
RIO GRANDE
DOLORES
HUERFANO
Walsenburg
MONTEZUMA
Cortez
ALAMOSA
Alamosa
Monte Vista
MESA VERDE NAT'L PARK
Durango
LA PLATA
ARCHULETA
CONEJOS
COSTILLA
SAN ISABEL
Trinidad
LAS ANIMAS
SO. UTE INDIAN RES.

THE ROCKY MOUNTAIN ALPINE TYPE

Range Conditions, Trends, and Land Use

by

H. E. Schwan and D. F. Costello [1]

INTRODUCTION

Importance of the Alpine Type

The alpine type in Colorado covers at least 2½ million acres, and in Wyoming 2,200,000 acres. The term "alpine" applies best to that area above the upper limits of tree growth. "Subalpine," as used here, applies to the zone of decumbent or scrubby and patchy coniferous trees extending above the spruce-fir forests below. Since climatic conditions and floristic composition are essentially similar in both areas, the entire zone above the upper limits of true forests is here broadly designated as the alpine type.

The importance of the alpine type stems from its multiple-use aspects. The 5½ percent of the surface area of Colorado, in the alpine type, accounts for more than 20 percent of all the stream flow in the state. Similar ratios prevail in Wyoming. Since fully one-half of the annual precipitation of approximately 35 inches leaves the type as stream flow, each acre produces at least 1½ acre-feet of water. This water production is strongly influenced by the condition of the alpine turf, by presence of willows, and by the degree of sod breaking and gully erosion induced by livestock.

The alpine type is important as game range and a home for wildlife. It is the normal habitat of Rocky Mountain goats (recently introduced into Colorado) and of ptarmigan. In certain areas both elk and mountain sheep remain in the alpine zone year long. More commonly these species, together with deer, use the high country only in summer. Elk, particularly, and possibly other species, locally, may be important sources of damage to alpine willows and other plants.

In the field of recreation, the alpine type has appeal and is a source of inspiration to many people through its attractions as an area for mountain climbing, photography, pack trips, and fishing in high-altitude lakes. Grazing and other uses, in the absence of good management, are likely to impinge on recreational values, including use of alpine flower fields, strategic pastures for horse feed, and denudation of camp sites and lake shores.

As a grazing resource, the alpine type is ideally suited for sheep, and particularly for the production of lambs in a cool climate on succulent

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1/ Range Examiner, U. S. Forest Service, Denver, Colo., and Range Examiner, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, respectively.

forage. Although cattle range extends above timberline in several localities, there is danger from brisket disease and occasional heavy losses have been noted.

A large fund of information has been accumulated on alpine taxonomy and ecology. However, land use problems in the high country have been studied in less detail, particularly as they affect watersheds, wildlife, livestock grazing, and other aspects of economic use. The background material used here includes information from 200,000 acres of national forest surveys and nearly 2,000 sample plots on which density and forage composition were recorded in a forage inventory made by the Experiment Station.

This guide describes the alpine type of Colorado and Wyoming. Some of the phenomena relating to the vegetation are discussed, particularly as they are caused or modified by grazing animals. Certain guides, criteria, and standards are proposed to aid administrative men in judging trend and conditions of the range and in translating their judgments into suitable administrative action plans.

The authors solicit constructive criticism and comments from the field as additions to the fund of knowledge of this important zone 2/.

THE ALPINE ZONE

The alpine zone extends southward in three main prongs from its juncture with the arctic flora in Alaska, Northern Canada, and Greenland. In the East, one segment occupies the highest summits in New England. The Sierran alpine segment is found on mountains from Canada and northwestern Montana to the Pacific Coast, and southward, west of the Great Basin, to its termination on San Jacinto Mountain in California. The Rocky Mountain segment of the alpine type occupies the mountain ranges between the Great Basin and the Plains from Montana southward to its last outposts in the Sangre de Cristos in northern New Mexico and the San Francisco Peaks in Arizona.

The upper edge of the true spruce forests is located about the 11,800-foot contour in southern Colorado. In northern Colorado, it is near the 11,000-foot mark, and in extreme northern Wyoming at about 9,500 feet. True timberline, or the extreme upper edge of the scrub coniferous timber, usually is about 500 feet higher. These altitudes vary locally with topography.

Physical Characteristics of the Alpine Type

In this high country, physical and climatological conditions are extremely severe in some respects and favorable in others. Temperatures are low, and frosts may occur any day of the year. Wind

2/ The authors acknowledge the helpful comments and criticisms received from Clarke Anderson, Arthur Cramer, W. R. Chapline, Walt L. Dutton, Ralph Gierisch, R. R. Hill, John V. Leighou, Paul G. Lundell, D. L. Love, Kenneth W. Parker, G. D. Pickford, W. E. Pool, Joseph T. Radel, J. L. Retzer, Benjamin F. Rice, Clinton Wasser, Waldo E. Wood and others.

velocities are high and result in high transpiration rates. Sand and snowblast injure plants; very high intensity sunlight prevails. Various phases of geologic erosion are pronounced. Thus, rock-falls, slips, snow-slides, and heavy spring runoff continue to modify the landscape.

On the other hand, annual precipitation is high--averaging, for example, about 30 inches on Pikes Peak and much more in places on the main chain of the Rockies. Drought conditions are seldom approached.

Alpine soils are usually stony or gravelly. As a general rule, they are not so subject to compaction as are most valley soils. The common and characteristic stone mulch or organic mulch, depending on the locality, retards evaporation and erosion. Slow decomposition of organic matter results in soils with high humus content. Water-holding capacity is high wherever vegetation is well developed. With local exceptions, the parent rock in the Rocky Mountain alpine type is granite and similar or related non-basic rocks. Therefore, soils are frequently acid. As the A horizon develops and increases in depth under an alpine sod, the trend is toward increasing acidity in the root zone. Normal plant succession in this type is closely related to increasing soil acidity 3/.

On slopes the alpine soils frequently consist of a shallow layer of mixed organic material and gravel. Disturbance of this layer results in slips and slides. Natural terracing is a common feature of the alpine landscape. This may be due to a variety of causes as talus flows, glacial moraines, and land slips. The brow of each terrace is frequently willow covered, or at least well vegetated, and the face is often wet and covered with plants. These terraces have the effect of "stepping down" waterflow from the steep slopes, and the dense vegetation effectively filters sediment.

The Vegetation

The alpine landscape is characterized by a wide variety of sites. Thus, the presence of ridges which are bare in winter, snow pockets, rock fields, slides, bold promontories, peaks, and sheltered coves may appear to be hopelessly without pattern. However, each of these local variations may be assigned to one of four principal habitats, each with its accompanying vegetation community--the rocky summits, bogs, willow fields, and alpine meadows. It is with the alpine meadows and with the closely-associated subalpine transition immediately below that we are chiefly concerned in judging condition of the range and in developing management plans. The other sites are essentially unusable, possess little grazing capacity, or have utility only in connection with the major community, the alpine meadows.

3/ Braun-Blanquet, Dr. J., Plant Sociology, McGraw-Hill Book Company, New York, 1932.

The Rocky Summits--On high exposed mountain tops, ridges, and steep side hills the action of freezing and thawing may result in large expanses of barren bedrock or slides and talus slopes of bare rock rubble. Where the slope is not excessive, smaller particles may lodge and provide a habitat for cushion-plants. The low, dense, rounded form, reduced leaf surfaces, oftentimes greyish color, and other devices for protection against excessive transpiration, intense light, and sand and snowblast adapt these plants to the harsh environment. Frequently, bluegrasses*, sedges or trisetum and other plants become established within the clumps of mat plants. Bellard's Kobresia, the climax dominant, is usually associated with alpine, letterman, patterson and timberline bluegrass, trisetum, sedges, and some forbs. Draba, ligusticella, sandwort, starwort, sibbaldia, nailwort, clover, and avens are perhaps the most common. Skyland, snow and summit willows, and mountain dryad are the only common shrubs.

Owing to shallowness of the soil, erosion hazard, low palatability of the plants, and generally meagre forage production, the rocky summits are not considered here as having appreciable grazing capacity. Their use in the grazing scheme should be only incidental.

The Willow Fields--These consist of dense, often extensive, stands of willows from 2 to 8 feet in height, which usually occur in the subalpine zone, but commonly extend somewhat into the true alpine zone above. Several species of alpine willows, including grayleaf, barren ground, false lapland, and two forms of planeleaf willow, are common. Within the shelter of the willows there is ordinarily a light understory of tall forbs such as larkspur, bluebell, ligusticum, butterweed groundsel, and drymocallis. Where the willow stand is opened up by sheep grazing or other means, the high-altitude bluegrasses, tufted hairgrass, Thurber fescue, or Canada reedgrass often become more abundant. When a stand is largely or completely killed and the effect of its shelter is lost, the characteristic grass-sedge or sedge-forb mixture usually predominates.

The Alpine Bogs--Many of these areas originally were ponds or shallow lakes, although they also develop where extensive seeps and springs occur. In shallow standing water quillwort is commonly the first aquatic. Usually sedges, marsh marigold, and other plants move out into shallow water on the leeside. This process gradually fills the pond. Unless there is a considerable addition of wind or water-borne mineral soil, the area will remain boggy. A characteristic cover of well-developed alpine bogs is one composed of sedges, with willows on better-drained areas. Elephanthead pedicularis is usually distinctive in bogs. Unless they are quite dry and merge into the alpine meadow aspect, the bogs are not suitable for sheep grazing.

The Alpine Meadows--These are the principal grazing areas in the alpine zone. They occur from the spruce-fir zone (subalpine transition) to the rocky summits, and include within their matrix the bogs, ponds, and upright willow stands. Essentially, they are the long slopes above timberline where sheep find ready access to forage.

*A list of scientific and common names is included in the appendix.

The aspect is often grassy, although several species of sedge usually are dominant. Common plants are yarrow, actinea, agoseris, arnica, paintedcup, willowweed, fleabane, avens, bluebell, penstemon, bistort, senecio, sibbaldia, and clovers. Several grasses, particularly species of redtop, alpine and spike oat, tufted hairgrass, alpine timothy, trisetum, alpine, arctic, letterman, and timberline bluegrass are common. On drier, well-sheltered sites, Thurber fescue, sheep fescue, danthonia, or subalpine and letterman needlegrass may be dominant. Succulent plants like bluebells, swertia, buttercup, and globeflower are more common than the cushion plants.

In sheltered cirques (rincons) and at lower elevations the type merges into the subalpine transition and loses its alpine aspect. This zone may be grassy, usually with Thurber fescue, sheep fescue, or tufted hairgrass predominating, or it may be dominated by taller, succulent forbs, usually in a complex mixture with willows and other species. Decumbent, scrubby alpine firs and spruce coalesce with the upper forest edge of whitebark or limber pine, spruce, and fir. The elements of subalpine vegetation have a very close affinity with the alpine type and this zone may properly be regarded as an extension of the alpine meadows.

Alpine Succession

The alpine climax community is represented by an association of sedges, grasses, and forbs in which Bellard's Kobresia is dominant. This sedge, in the highest development of the climax, forms a sod which virtually excludes all other plants. Pure stands of Kobresia seldom occur over large areas because of interruption by other plant communities which are determined by variations in exposure, slope, rock outcrops, and other physical and climatic features.

The climax is reached through either the hydrosere or the xerosere. The stages in succession from bare rock to climax give rise to various communities, characterized by readily recognizable growth forms. The xerophytic succession starting from dry rock normally proceeds through the lichen-moss stages, to forb-grass communities, to sedge-grass, and finally to the Kobresia climax. The hydrophytic succession starts in basins and wet situations, and develops through the grass-sedge stage to moist meadow, and ultimately to the climax association.

Normally the cushion plants are the first pioneers on new soil on rocky ridges and gravel slides. The cushion plants provide suitable conditions for the germination of seeds and for seedling survival of taller forbs, sedges and grasses. As these develop, mulch accumulates, snow is held and conditions become less favorable for the cushion plants and better for the grasses and sedges. Secondary succession, induced by the destruction of cover, as by grazing, therefore,frequently begins with the cushion plants and progresses toward Kobresia.

Willow fields are usually considered to be postclimax on rich moist soils, on protected slopes, and in valleys. They represent a stage in development beyond the Kobresia climax, and thus indicate local conditions (soil, moisture, climate) more favorable than those which delimit the climax.

Trend Indicators

The range is dynamic rather than static, and improvement or deterioration of plants and soil go hand-in-hand. Each influences the other. The dying out of plants or loss of organic mulch may result in lowered soil moisture, and physical deterioration of the soil. On the other hand, an increase of organic matter may result in more moisture, accelerated plant succession, and improvement in quantity and quality of forage plants. These interactions are influenced not only by grazing animals, but by many other factors--some inherent to the site and beyond the scope of reasonable management.

Plant and soil indicators are the signs on the landscape which enable the range examiner to read the range. Since deteriorated range condition indicates the relative position of a given range in relation to the optimum, or highest, developmental stage of the soil and vegetation, it is natural that the signs of degradation, retrogression or arrested development should be conspicuous. Some of these important indicators are discussed below:

1. Sod breaks. If there are numerous trails, broken places, or a series of short, broken terraces with bare or nearly bare faces, it is a sign that deterioration has taken place or is in progress. Sod breaks usually occur on steep or moderate slopes--occasionally on very gentle sloping land or where soil is deep. They indicate that the pressure of grazing animals is too great and that the travel incident to grazing has cut through the shallow sod. The occurrence and extent of sod breaks can usually be best observed across a small valley or by observing somewhat distant slopes. The observer should differentiate between sod breaks caused by grazing and slumps resulting from natural phenomena.

The presence of well-established young grasses and sedges, in the breaks, and especially on the upper face of the break, is a sign that improvement is taking place. Local improvement may occur even when the general trend is still downward. Before an upward trend is indicated, revegetation must be distinctly evident throughout the area of sod breaks.

2. Scalped slopes. Frequently, on steep slopes patches of sod, usually a few feet square, but often a hundred or more feet across, may slide out where livestock trails have cut the sod. These scalped areas may be distinguished from natural snowbank areas in that there usually are sharp sod edges, and they occur indiscriminately on ridges and slopes of different exposures where snow does not always accumulate. Even natural mass soil creep can be accelerated by excessive trampling by livestock.

On some steep slopes and near mountain or ridge tops extensive areas of sod may be slashed into narrow ribbons from trailing by domestic stock or big game animals. The slope has a ragged appearance with much bare ground and strips of sod remaining as remnants.

Healing is ordinarily very slow because it often involves rebuilding the soil. However, cushion plants usually invade and grasses and sedges

advance inward from the edges. On snowbank areas plants like buttercup, globeflower, and springbeauty usually appear on the bare edges, but there is no evidence of the more permanent grasses and sedges pioneering on the raw ground.

3. Willow damage may be evident as dead branches on willow clumps, extensive trailing into the patches, completely dead standing willows, or merely a few dead stems lying on the site of former willow fields. Most frequently, areas of hummocks indicate the former presence of willows. With the disappearance of the shrubs, the site dries out and compaction is hastened by the entrance of grazing animals. Thus, the former ground level persists only around the old willow stumps. The light stand of succulent weeds disappears and Thurber fescue, tufted hairgrass, sedges, or alpine bluegrass occupy the site. Gullies, following overgrazing, may hasten the drying-out process.

The earliest evidence of willow damage is excessive browsing. Later the edges of clumps are killed, giving them a raw appearance.

Healing is usually evidenced by new willow sprouts and new plants not currently grazed. New growth takes place along the raw edges where the patches have been killed back, thus gradually returning them to the rounded windbreak forms which keep the force of alpine winds and driven snow out of the patches.

It should be borne in mind that elk and deer, as well as sheep and cattle, cause willow damage, and the cause must be properly assigned in order to correct excessive use.

4. Snowbank trailing. As a result of excessive numbers of sheep or poor herding, damage may occur around snowbanks or snowbank areas--usually at the sides or above the snowbank. This damage is evident as a network of sheep trails converging on the bank, and trailed-out spots and broken sod above. This is a fertile source of local erosion and sedimentation.

Recovery takes place as described under "sod breaks." The main area of the snowbank frequently remains devoid of vegetation.

5. Pedestalled plants. Usually on more level areas where sod breaks do not occur, plants may be pedestalled. These are generally the result of excessive trailing. They indicate that soil has been removed through erosion, thus lowering the surface of the ground. Pedestalling is common along driveways and in gaps. Where preferred plants have been killed, only coarse grasses and sedges remain, with the result that sheep travel widely in search of palatable forage.

Healing must take place with the establishment of a new sod on the lowered ground level. The extensive presence of well-established grasses, sedges and forbs between the pedestalled plants indicates the beginning of recovery. Low-value plants, like sibbaldia, frequently are the first to invade and start the healing and recovery process.

6. Fresh gravel fans. These frequently occur in glacial cirques and basins. Ordinarily, in fans that are presently aggrading, drainage ways are evident across the fan and frequently higher than surrounding stabilized areas. The fans in themselves indicate only an acceleration in local erosion. The cause may be snowslides, shifting of water ways because of rock falls, trailing and disturbance by grazing animals, or deterioration of the watershed above the point of origin of the gravel flows. An inspection is necessary to determine the cause.

Recovery is evident when the fans become revegetated. Usually willows and certain forbs rather than grasses are the first invaders. Black groundsel commonly is an early pioneer.

7. Raw gullies and vertical stream banks. These always indicate accelerated runoff and frequently indicate overgrazing. Where these indicators are due to overgrazing, the sod edges are usually sharp, ragged, and often undercut. When the bare areas are due to snowbanks, the edges usually merge gradually into the surrounding vegetation, generally with a zone of quickly maturing forbs around the edge. Here, where the earliest melting of the snow provides a longer growing season, buttercups, springbeauty, compositae, and several other low forbs usually are the first pioneers. Snowbanks frequently accumulate in drainage ways and the bottom of the gulch may be V-shaped due to heavy runoff below the snow. Ordinarily, the bottom is well covered with rock rubble and little soil movement takes place. Shallow, raw gullies, especially when these form networks are surer signs of accelerated soil erosion than large, short, deep gullies which may hold snow until late summer. Undercutting of banks along main creeks usually indicates increased runoff or destruction of protecting bank vegetation.

Recovery is indicated by flattening of the slopes and the presence of a widespread, well-established stand of new vegetation. Tufted hairgrass is a common invader on bare soil. Frequently chunks of sod break off and take root on bare slopes giving a false impression of recovery.

8. Discolored or silty water. Water emerging from wet alpine meadows is sometimes discolored from the peaty soil. This is a natural phenomenon of the high country. When silt is present, the cause should be investigated, as suggested under "gravel fans." While water volumes commonly are greater in early summer, the established drainage ways either have been scoured free of transportable material during many years of runoff, or have been stabilized by vegetation. Natural changes in the landscape, incident to normal base-leveling, may provide fresh material, but normally, alpine streams are clear and sparkling, not muddy or silty.

9. Absence of mulch. Mulch may not accumulate on exposed rocky summits. In meadows and bogs, on the other hand, the substratum is largely organic matter, and the current addition of mulch may be difficult to detect. However, in the drier sedge and grass areas mulch accumulation should be similar to that in the bunchgrass ranges of lower altitudes. Interspaces between living plants should have a continuous mulch cover on sites in the best condition.

Lack of organic mulch usually is due to excessive utilization by grazing animals. Insufficient green material is left to form mulch. Also, when mulch is mixed with mineral soil, as by excessive trampling, its effectiveness in preventing surface compaction is very largely lost and its rate of decomposition is greatly accelerated.

10. Presence of low-value plants. Wherever one or two species begin to dominate an accessible range and create a "one-species appearance," other factors should be checked carefully. Usually it is a sign that better species are being thinned out. Where tufted hairgrass, Thurber fescue, or letterman needlegrass lose their succulence early and appear in nearly pure stands with few weeds between the plants, past sheep overgrazing is generally indicated. Excessive stands of the following genera and species serve as overgrazing indicators: rushes, yarrow, pussytoes, fleabane, avens, and sibbaldia. However, these are also site indicators and range condition should never be judged only by the presence of these plants. Ligusticella serves as an indicator, especially when it is very low and matted. The nodding hoary thistle as well as the birdsnest thistle may become abundant locally and, in some cases, an increase in lupine indicates overgrazing.

11. Low densities. Density estimates indicate the amount of vegetation cover on the ground, or by limiting the estimates to certain plants, they indicate the amount of valuable or desirable vegetation. In the alpine type it is preferable to consider all herbage regardless of relative value.

Low densities or lack of vegetation may indicate a deteriorated range, or one in which the sparse cover is due to such factors as wind, rock, snow, or lack of soil, or others.

In addition to the above, there are numerous commonly used indicators which have value if they are properly interpreted. To show positive improvement these indicators should be evident on a considerable area; they should be showing evidence of improvement over several years, and they should not be outweighed by indicators of continuing deterioration.

Some of these indicators of range improvement are:

a. New shoots, preferably more than 1-year old, on low willow clumps or on shrubby cinquefoil. Raw or dead edges of willow fields healing over with new growth.

b. Well-established grasses and weeds beginning to cover sides of raw banks and gullies. New grasses and palatable weeds invading sheep trails and around edges of snowbanks. New sod forming on scalped areas. Invasion by such plants as yarrow, sibbaldia, weedy cinquefoils, and avens may indicate continued deterioration, if they replace more valuable vegetation on extensive areas. These same plants also usually are the first invaders where the healing of bare spots has begun.

c. Only light utilization of preferred plants as upright clovers, larkspur, bluebells. Good vigor and numerous flower or seed heads on preferred species. At least 50 percent of new growth on most accessible willow clumps remaining after sheep have left the area.

d. Healing of outwash fans by palatable weeds and grasses. Establishment of such plants as black groundsel and fleabane do not necessarily indicate improvement.

e. Positive accumulation of new mulch on areas other than windswept summits.

For general purposes, two inferential methods of judging range trend are very useful:

(1) If the earmarks indicate a deteriorated range, and if the records show no reductions or radical changes in management during recent years, it is safe to assume that the range is not improving.

(2) If the earmarks indicate a damaged range, and if current utilization is excessive, range deterioration will probably continue.

The most reliable method of checking range trend is by means of permanent plots, belt or line transects, in which the quality and quantity of various species present and the amount of mulch may be accurately plotted or charted and compared against records at 3- to 5-year intervals. It is highly desirable to supplement such records with photographs.

JUDGING RANGE CONDITION

The standards described here apply specifically to alpine meadows and only in a general way to the other alpine sites, where grazing capacity is normally low, or inaccessibility or other factors make grazing impracticable. The condition classes conform broadly to successional stages, but not precisely because of innumerable deflections and modifications from normal succession. They are more nearly a measure of relative productivity.

When the examiner or administrator inspects a portion of the alpine type, he immediately notes certain "earmarks" or indicators. These are valuable general clues to the prevailing range condition. A good understanding of the alpine type will enable him to interpret them correctly. Observance of some broad rules will, therefore, aid him in making an accurate analysis.

1. He should remember that physical environmental conditions are extremely heterogeneous. Snow pockets, windswept ridges, slides, swamps, rock fields, and deep-soiled basins and slopes may seem like a confused and jumbled landscape, but each can be identified as a modification of the main alpine sites--rocky summits, bogs, willow fields, and alpine meadows.

2. The key area concept of judging range applies to the alpine type just as it does to ranges at lower altitudes. Generally, the best key areas are the alpine meadows, broadly including the subalpine areas

immediately below. These are the most extensive areas and generally furnish most of the grazing. The postclimax willow communities, as a rule, are present in the alpine meadow site. The rocky summits are more susceptible to damage but are usually of limited extent. They should also be inspected. Bogs are not suitable for sheep grazing except where firm soil is well developed and where they merge into alpine meadows.

3. Since sheep grazing occurs during the time of flowering and seed setting, a heavily grazed range may be marked by a scarcity of alpine forbs, especially the upright and relatively succulent species. Grasses, because of their higher palatability, also may be thinned out. On such a range various alpine sedges, and less palatable grasses, are frequently the dominant vegetation. However, the range man should bear in mind that the natural succession is toward sedges and Kobresia and toward willows.

4. The soil indicators of an unsatisfactory condition are more noticeable than the vegetation indicators. Willow damage is an exception.

From the general indicators the range man can, and should, first decide if the range is in satisfactory or unsatisfactory condition. Then, by means of an orderly appraisal of each of the five criteria, composition, density, vigor, mulch, and soil indicators, the satisfactory range should be placed in either the excellent or good classification, and unsatisfactory range may be segregated into fair, poor, or severely depleted condition classes. Unusable range should not be included.

The step-point method 4/ is the standard upon which density recommendations in this handbook are based. To judge the density of herbage, the examiner makes a mark or notch about one-eighth inch wide on the point of one shoe sole and takes 100 paces (termed a transect) through a representative area. He may note the paces mentally. He records each "hit," when the mark falls directly on living vegetation, by any convenient means. The simplest method is to transfer a pebble from a supply in one hand to the other hand. The number of pebbles so transferred gives the percentage density.

The course of the transect should be so designed as to sample a representative part of the vegetation. The examiner should avoid bias by walking with normal steps, and by looking at the mark after it strikes the ground. Ordinarily, in areas of any size, several transects are desirable to obtain a fair sample.

Composition may be sampled with this method by recording on paper the number of hits on each of a number of selected species.

4/ Costello, D. F., and Schwan, H. E. Conditions and Trends on Ponderosa Pine Ranges in Colorado, U.S.F.S., Denver, Colorado, mimeo. 1946.

Criteria and Standards--Range Condition Classes

Excellent Condition

A good mixture of vegetation, climax species usually prominent, vigor high as evidenced by density, height, size of plants, and numbers of flowers. No noticeable shrub damage. Continuous mat of mulch in sheltered places. No sod breaks, scalped areas, trailing, hummocking, or gravel fans.

Composition--At higher elevations Kobresia is usually conspicuous locally as solid sod or colonies. Several grasses as alpine, arctic and timberline bluegrass, alpine timothy, and trisetum usually present. Several sedges common, some mat plants present. At lower edge of the zone, including the subalpine, major species are alpine oatgrass, tufted hairgrass, sheep and Thurber fescue, alpine timothy, trisetum, and sedges. Willows are usually present on the better sites. Paintedcup, willowweed, bluebells, arnica, groundsel, bistort, several clovers, and other forbs usually are abundant on the deeper soils.

Density--Density of all vegetation is commonly 80 percent or more. Normally, vegetation covers the ground completely between large rocks.

Vigor--Vigor is high. Kobresia is commonly at least 6 inches high, except on exposed ridges. Cushion plants are inclined to be loose and leafy rather than hard, compact rosettes, especially where force of wind is broken as in boulder fields. Flower and seed stalks are abundant. There should be no discernible shrub or willow damage.

Mulch--A continuous mat of fresh mulch is present. Light organic mulch occurs on exposed areas.

Soils--Sod breaks, scalped slopes, snowbank trailing, pedestalling, fresh gravel fans, and raw gullies are completely absent. A well-developed layer of organic soil is present except on exposed areas which are subject to the violent force of the wind.

Good Condition

In the good condition the type may have deteriorated and has recovered, leaving evidence of old scars now well healed; or local topography, site and vegetation conditions are below the general type optimum.

Composition--Essentially the same as described under "Excellent." Sedges often predominate. There is greater abundance of cushion plants on exposed summits and rock fields, but the aspect is dominated by Kobresia, sedges, bluegrasses, oatgrass, upright forbs and willows.

Density--Density of all vegetation varies from 60 to 80 percent.

Vigor--Essentially as described under "Excellent." There may be some evidence of willow browsing where sheep congregate; usually very local.

Mulch--As described for "Excellent." Some limited exposed stony areas, except on natural boulder fields, occasionally are present.

Soils--Strictly limited and localized minor sod breaks and snowbank trailing may be noticeable, but only where sheep tend to congregate, usually because of topography. Scalped areas, pedestalling and gullying are absent.

Fair Condition

Here evidences of grazing or of inferior site are distinctly noticeable. The range has suffered some damage, usually local in nature, but it is capable of being remedied in a reasonable length of time and with moderate management changes.

Composition--True sedges and grasses, as fescue or trisetum, rather than Kobresia, usually are dominant. Cushion plants are common with such plants as sandwort, phlox and dwarf, or alpine clover predominating. Golden avens and sibbaldia frequently common in localized areas.

Alpine meadows frequently have a high density but often have a uniform tufted hairgrass or sedge cover with few palatable weeds. Such low-value plants as yarrow, sibbaldia, and golden avens are common in colonies or mixed with the better plants. Fleabane, speedwell, American bistort, alpine sage are sometimes abundant in moister areas. Subalpine needlegrass, Thurber fescue, tufted hairgrass, and sheep fescue are conspicuous in local areas, especially in the subalpine transition. Baltic rush, spiked woodrush, chickweed, sibbaldia, or pussytoes are common on small concentration areas.

Density--Density of all vegetation is usually 40 to 60 percent, although in the sedge types it may be higher. The cushion plant--grass-sedge formation of exposed sites is usually patchy or broken.

Vigor--The cushion plants are usually low, groundhugging, and in colonies or patches. Kobresia often is short--4 inches or less. Usually, there is a scarcity of highly succulent forbs. Willows show occasional to frequent damage from browsing, some dead branches and perhaps some trailing into the clumps. There is no extensive willow kill. Weeds like larkspur and butterweed groundsel are well back in the willow clumps.

Mulch--Mulch in the alpine meadows may be in broken patches with as much as 50 percent bare ground showing (litter covers 50 percent, or more, of the interspaces between plants). Noticeable stony pavement occurs on exposed sites.

Soils--Sod breaks and scalped places may be locally present, but in this condition class somewhat distant hillsides seldom appear as a network of sheep trails. Snowbank trailing is often common. Plants are pedestalled only in localized areas where trailing has occurred.

Poor Condition

Ordinarily, there is still a dense cover of vegetation on moist slopes, low-value plants are generally abundant, accessible willows are dead, and

there is widespread severe damage to the soil and watershed, especially on slopes and summits where soil is thin.

Composition--All of the succulent plants are rare except in swampy areas. Golden avens, yarrow, sibbaldia, fleabane, low weedy cinquefoils, pussytoes, and similar plants occupy heavily grazed spots and, usually lend aspect to extensive areas; or the aspect may be a uniform tufted hairgrass cover. Short sedges, spiked woodrush, trisetum, and sheep fescue are sometimes abundant. Isolated willow clumps and willows on accessible areas are dead, and may persist as stubs or dead wood. Extensive areas are often badly trailed.

Density--Density of all vegetation on representative, drier sites usually ranges between 20 and 40 percent, but it may be higher on moist slopes in meadows and the subalpine transition. The summits may be largely bare with widely spaced colonies of mat plants.

Vigor--Vigor is generally low. Grasses are short and plants like ligusticella are matted and groundhugging. The grass and sedge types frequently have a trailed out appearance. Seed stalks are few in number.

Mulch--Organic mulch is light or lacking on areas accessible to grazing animals.

Soil--Many or most of the soil deterioration indicators are present. On very flat areas, soil removal by wind and pedestalling is usually evident. Small passes or benches where sheep must bunch to pass are generally barren, eroded and the source of shallow to deep gullies. Often the most conspicuous features of this condition class are frequent raw gullies, especially at heads of drainages, and the network of trails or sod breaks, often with scalped places on slopes.

Severely Depleted or Very Poor Condition

The severely depleted condition is seldom encountered over extensive areas in the alpine type. Destructive grazing is usually confined to readily accessible areas. These present a ragged, broken, trailed-out appearance.

Composition--Sheep and Thurber fescue, subalpine needlegrass, and trisetum, as well as sedges and rushes, are often prominent. On dry flats the cover frequently consists of an open patchy stand of alpine sheep fescue, rushes, and a few matted, unpalatable weeds. Yarrow, ligusticella, potentilla, pussytoes, fleabane, and sibbaldia are abundant on readily accessible sites and on concentration areas. Exposed ridges and summits have many low cushion plants.

Density--Density on accessible areas frequently is less than 20 percent, although there will be nearby areas where it is much higher.

Vigor--Vigor is very low. Plants are short and groundhugging or pedestalled. Few seed stalks or flowers are produced. Frequently a single species such as lupine, avens, or sibbaldia may predominate, or it may form an over or understory in conjunction with unpalatable sedges. Willows are dead except on very steep slopes, in bogs, or other inaccessible places.

Mulch--Usually there is no mulch layer in the grass stands, although in less accessible places it may approach 25 percent.

Soils--The ragged appearance of thinly vegetated summits and slopes, caused by sod-cutting, is a distinctive feature. Sod breaks and scalped places are usually common, and slopes are badly trailed. Numerous shallow to deep gullies are evident at the heads of drainages. Stream banks are cut, raw, and sharp. There is often much snowbank trailing.

Unusable Areas

These areas include not only the barren rocks, precipitous cliffs, and extensive rock fields that are obviously unusable, but also small forage pockets, isolated plateaus and points, and fringes of pioneering vegetation around talus slopes and steep ridges. Invariably these areas are not used until the better, flatter, grazing areas are overutilized. The trailing of sheep across slides and slopes to reach these spots is usually destructive. These isolated places contribute most if they are reserved for wildlife.

ALLOWABLE GRAZING RATES

The first step in estimating grazing capacity is to outline on a map the barren spots, rock areas, areas with thin patchy soils, thinly vegetated slopes, small isolated patches of good feed and extensive steep slopes exceeding 40 percent, and consider such areas as being unsuitable for grazing. Willow fields should be examined carefully. All which are dense, extensive or on steep slopes should be regarded as waste and should be eliminated from the grazing capacity--do not include them in the usable range acreage.

In the best alpine meadows, sufficiently dry to permit grazing, available records indicate a capacity of 1-sheep month per one-half acre. Such types are extremely rare. On the other hand, stocking at a rate of less than 1-sheep month to 4 acres is considered uneconomical and physically impracticable. Based on detailed type studies the following broad stocking rates are recommended.

	Acres per Sheep Month
Excellent and good	1 - 2
Fair	2 - 3
Poor	3 - 4
Severely Depleted	No Grazing

These recommended acreage requirements are intended as general guides. Thus, a "high fair" may require 2 acres, whereas 3 acres may be required for a "low fair." These recommended stocking rates contemplate most use on 0-to 40-percent slopes. It is recognized that some use will take place on steeper slopes, but this is compensated for by making no reduction in stocking rate on moderate (20-40 percent) slopes as compared with gentle (0-20 percent) slopes. Grazing on slopes in excess of 40 percent should be incidental only.

To use the suggested stocking rates:

1. Eliminate all unusable areas on a map of the allotment.

2. Break the allotment into the major prevailing condition classes after these have been determined on the ground.

3. Compute the acreage of range in each condition class and apply the proper stocking rate to the range acreage in each condition class.

ALPINE RANGE MANAGEMENT [5]

The increased palatability of certain species or plant groups at higher altitudes should be recognized in management of alpine ranges. For example, Thurber fescue usually remains green and succulent throughout the grazing season in the subalpine and the lower edge of the alpine types. The result is that sheep may readily utilize 40 to 60 percent of these plants. At lower altitudes where Thurber fescue matures earlier and becomes harsh and dry, sheep use is ordinarily extremely light. The same principle applies to other grasses.

It has been demonstrated that the period of time necessary for a given species to complete the early growth stages (as from inception of growth to flowering) is progressively shortened with increasing altitude. [6] Thus, "for each additional 100 feet of altitude, 0.2 to 1 day less is required after active growth inception for grasses to reach 'flower stalks in evidence'." One reason for this is that "at higher elevations growth is delayed by snow cover, with the result that higher temperatures prevail when growth begins."

However, the later growth stages, from "flowers in bloom" to "seeds ripe" are commonly slower at higher altitudes. Lower prevailing daily temperatures, compared with those of lower altitudes, are considered to be responsible. The net result is that under prevailing growing conditions the alpine species are able to complete the annual cycle and mature seeds within the limits of their shorter growing season just about as successfully as species growing at much lower altitudes. They remain green throughout the growth cycle, and consequently do not decrease in palatability to the extent that is common to vegetation in lower zones. Summer dormancy, which commonly interrupts growth and volume production at lower altitudes, is rare in the alpine zone.

Some willow species are preferred to others by sheep. Thus, planeleaf willow, particularly Nelson's variety, is often destructively grazed

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5/ These recommendations are based on more than seven years of observation by the authors. During this time the opinions of many forest officers, ranch operators and herders were obtained and many administrative records were studied.

6/ Costello, David F. and Price, Raymond. 1939. Weather and plant development data as determinants of grazing periods on mountain range. USDA Tech. Bull. 686.

before false Lapland willow or grey willow are much utilized. Under the impact of grazing, a shift to less palatable willows takes place.

The dates when alpine ranges are ready to graze vary with altitude, exposure, and seasonal climatic conditions. Generally speaking, most of these ranges should not be grazed before July 15, except for minor local areas in the subalpine area. In some places where snowbanks are prevalent, grazing may need to be deferred until as late as August 15. Grazing should not begin until the major feed areas are firm and free from excessive snow-melt water. Flower heads on alpine bluegrass and tufted hairgrass should be well developed.

Grazing after September 1-5 is hazardous because of the suddenness offall storms. Because of these conditions, sheep allotments should be so designed that they will have one or more camps in suitable areas below timberline for grazing before July 15 and after September 1. If this is not feasible, the grazing season should be adjusted accordingly.

Areas of any size, containing patches of forage on very steep slopes, on developing soil on talus slopes, and in shallow-soiled basins should not be grazed and should not be included in the estimate of grazing capacity. The damage resulting from trailing to and from such areas and along excessively steep slopes is not commensurate with the value of the forage. This point cannot be overemphasized.

Generally, alpine areas suitable for sheep grazing should represent more or less continuous or connected areas of forage sufficient for a band of 600 to 1,000 ewes with lambs for the prevailing season, including low range in the allotment. Because feed areas are often small and discontinuous, small bands are usually best. Permanent sheep allotments should be considered only where prevailing slopes are generally moderate. The inclusion of some grazing areas on steeper slopes is often unavoidable, but only incidental use of these areas should be permitted. As an example, when a sheep allotment is located entirely in the head of a canyon with very limited forage in the bottom and with side slopes of 50 percent, 60 percent or more, it is doubtful if it can be grazed without serious damage to the soil. The exact grades of slopes which might be considered excessive are difficult to define, since depth of soil, length of slope, and condition of vegetation exert an influence. However, most of the forage grazed should be on range with slopes below 40 percent.

Large patches of upright willows usually contain a certain amount of sheep forage. Generally, however, the willows are so dense that sheep cannot penetrate them without severe trailing damage or without serious overbrowsing of the edges. From a practical standpoint, extensive willow fields must be regarded as waste range, unless they are relatively open or patchy. The plan of management should provide for virtual nonuse of dense, continuous willow stands. To do otherwise risks the eventual destruction of willow fields and the loss of other land values.

Because of the short season above timberline, sheep grazing corresponds with the time of flowering and seed production of forage plants. Also, it is unavoidable that some areas will still have some saturated ground when sheep enter. It is important, therefore, that a rotation grazing plan be

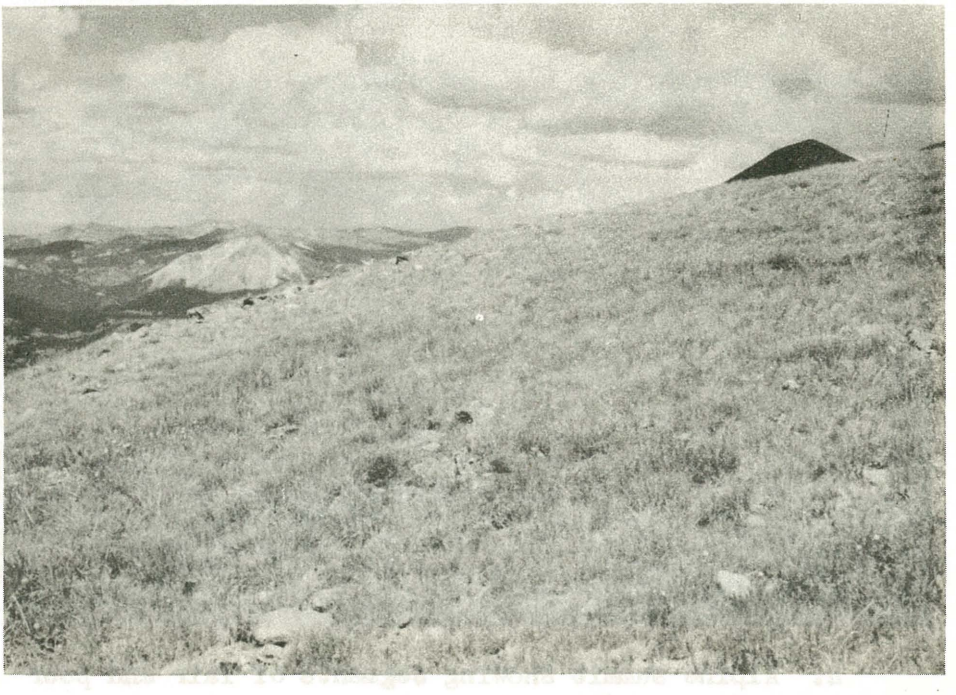
in effect. A simple but effective system is to reverse the band movement over the allotment during alternate years. More detailed systems can be designed on many allotments.

To the fullest extent possible, sheep should be kept off snowbanks and, especially off the wet ground around snowbanks, and off the saturated ground below. Certain local north and east slopes where much snow ordinarily remains very late might well be closed to grazing.

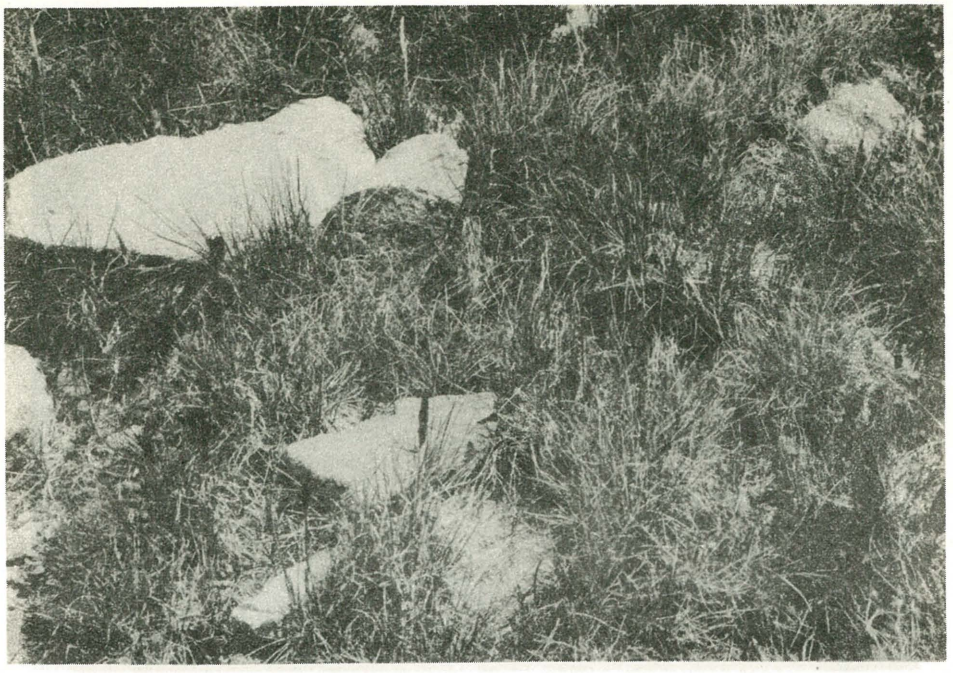
Grazing should be once-over, light, progressive, and without prolonged stops in favored areas. The practice of allowing sheep to browse their way back into willow fields for days or weeks in one location should not be tolerated. The practice of trailing sheep back to central bedgrounds is very destructive to the alpine sods. Progressive feeding and one-night bedding should be the prevailing method of use.

Because of the short season of use, danger of brisket disease and storms, which may occur during any month and cause unattended livestock to drift, the Rocky Mountain alpine type is not well suited for cattle grazing. A tendency toward low calf crops has also been reported where cattle are summered above timberline. It appears that those high altitude ranges, which can be safely grazed with reasonable management and without endangering the soil, water, or other land uses, can best be used by sheep.

1. Alpine summit in excellent condition. Suitable adjustments must be made in recommended stocking rates because of rock. Kobresia, Drummond sedge, spike woodrush, Colorado primrose, snow willow.

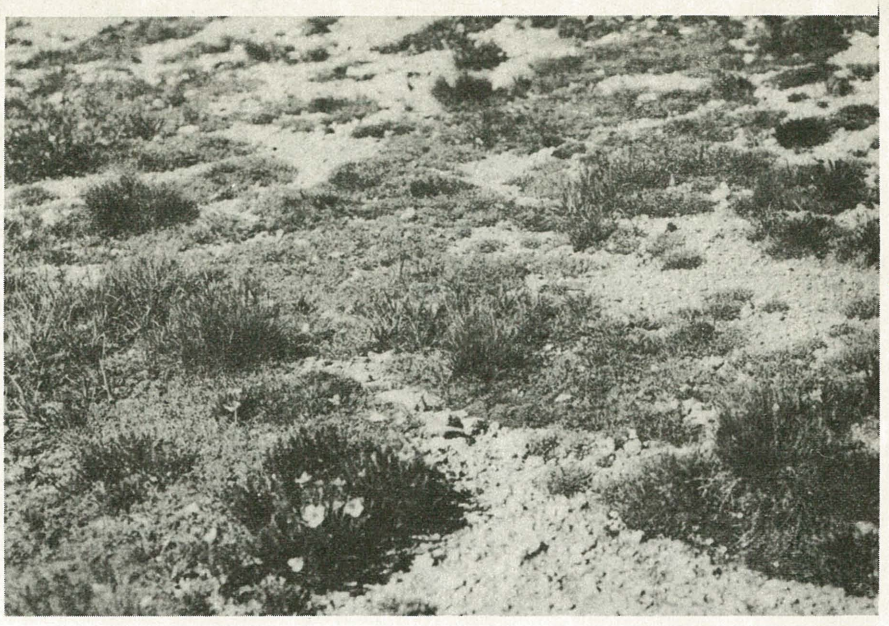


2. Alpine summit in good condition. Sod of Kobresia arctic bluegrass, sedges, rushes, graylocks actinea, western paintedcup, some cushion plants. Condition rated good. Small openings, rocks, and cushion plants affect rating.



3. Alpine summit in good condition. Detail shows Kobresia, sedge, trisetum, some cushion plants, organic mulch is light, but density is high between stones.

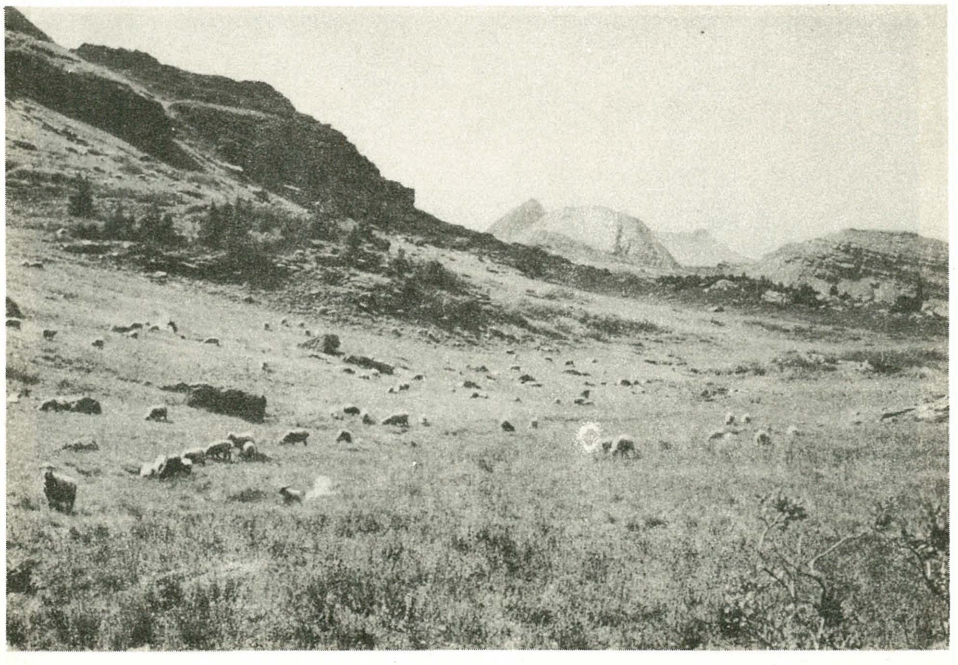
4. Alpine summit showing segments of fair and poor condition. Poor condition has extensive erosion pavement, and cushion plants,as dwarf clover, siberian sandwort, moss silene. Fair condition has a better sod with Kobresia and sedges in patches.



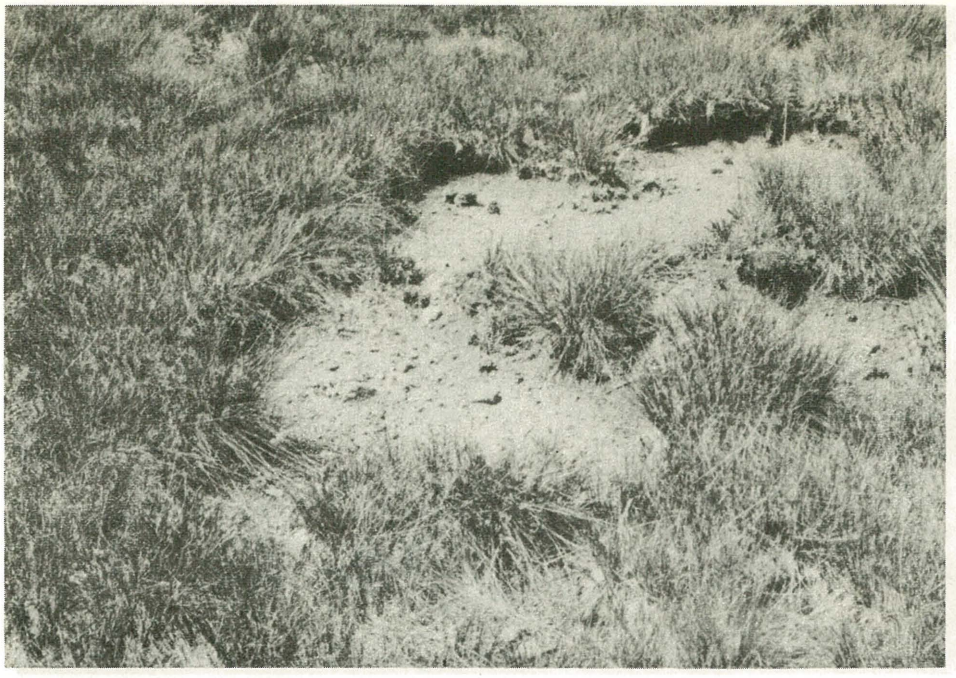
5. Alpine summit. Detail of poor condition. Typical stone mulch, organic mulch absent. Cushion plants with golden avens, alpine bluegrass and sedges developing in mats. Exposed stones cover about 50% of surface.

6. Alpine summit in Wyoming. Kobresia sod reduced to shreds as a result of intensive use by bighorn sheep and, probably, elk.

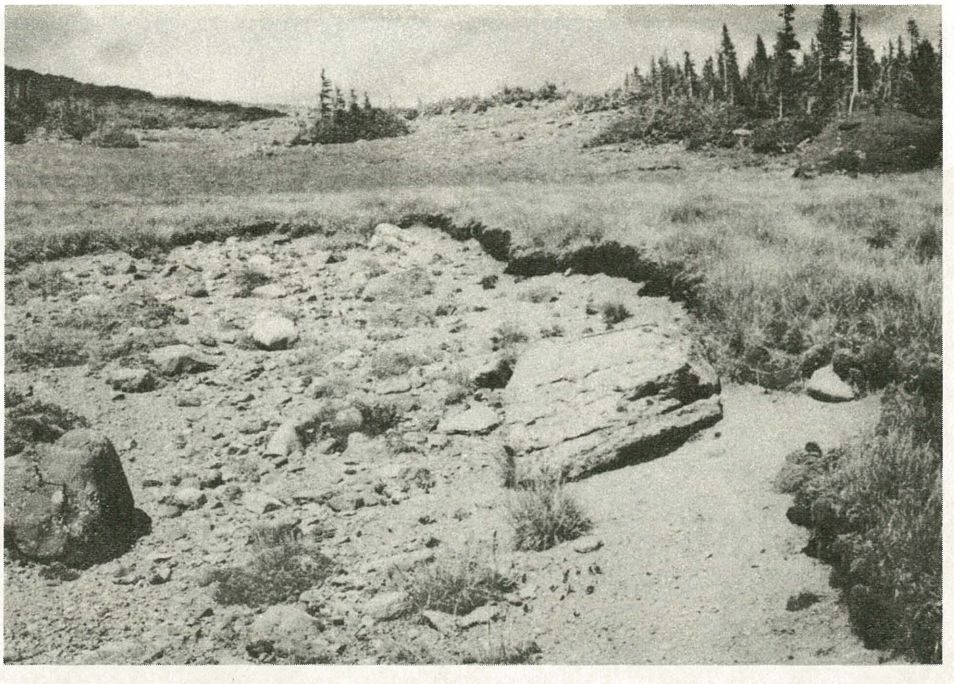
7. Alpine meadow. Excellent condition. Uniform mixture of grasses and forbs, very high vigor, no erosion, nearly complete cover. Alpine bluegrass, trisetum, alpine timothy, sedges, arnica, American bistort, orange agoseris.



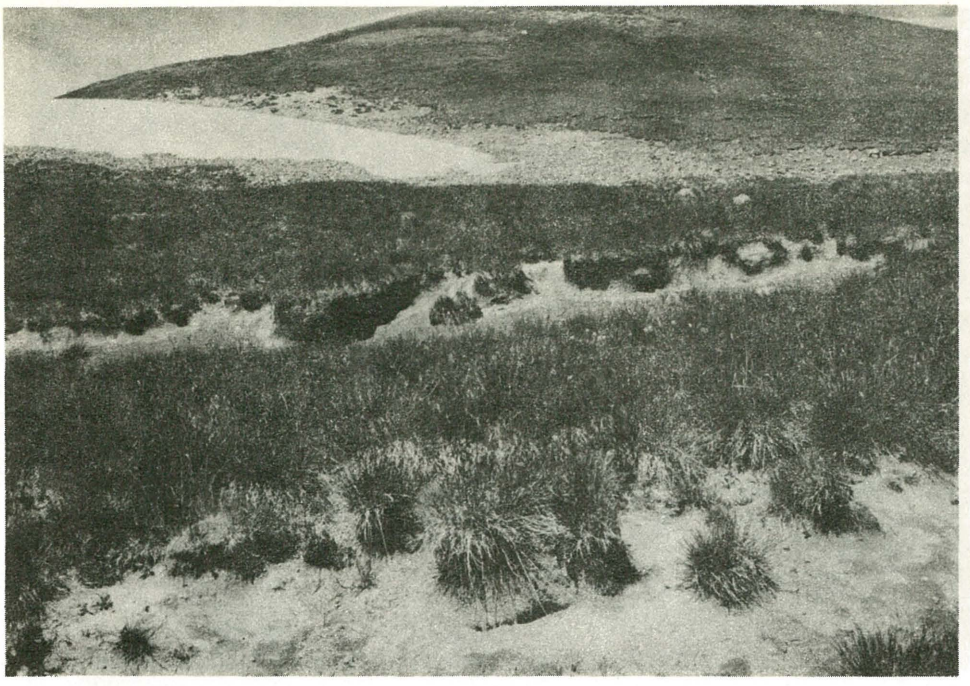
8. Alpine meadow. Good condition. Dominated by tufted hairgrass, alpine timothy, alpine bluegrass, some willow browsing noticeable.



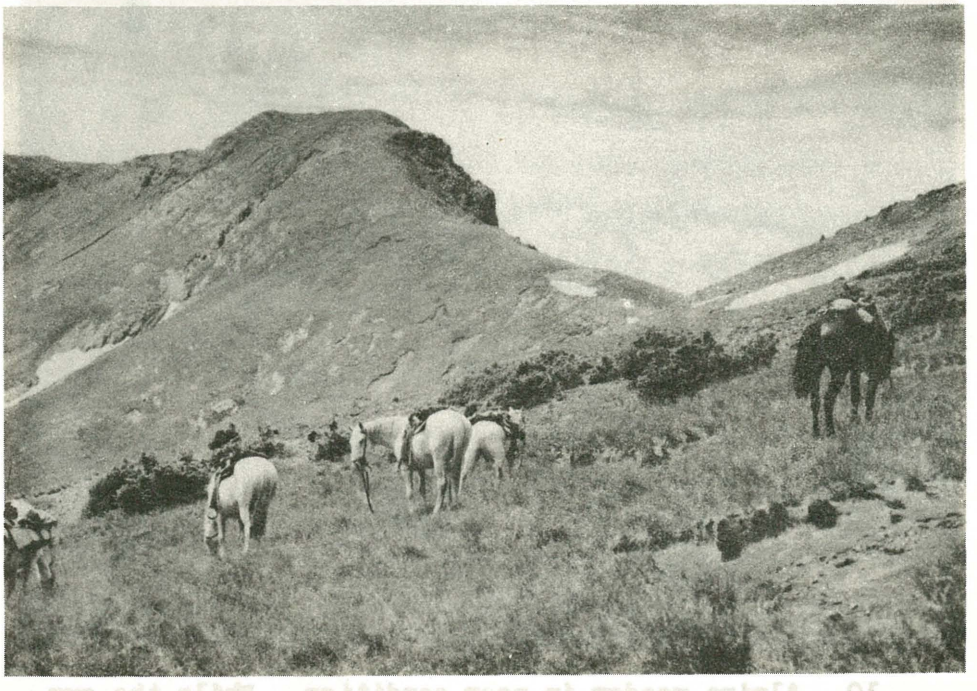
9. Alpine meadow in fair condition. Small sod break in hairgrass-bluegrass-sedge meadow. While density, vigor, and organic mulch are high, the condition is rated down because of composition, scarcity of forbs, and occasional sod breaks. These breaks can develop into damage as illustrated below.



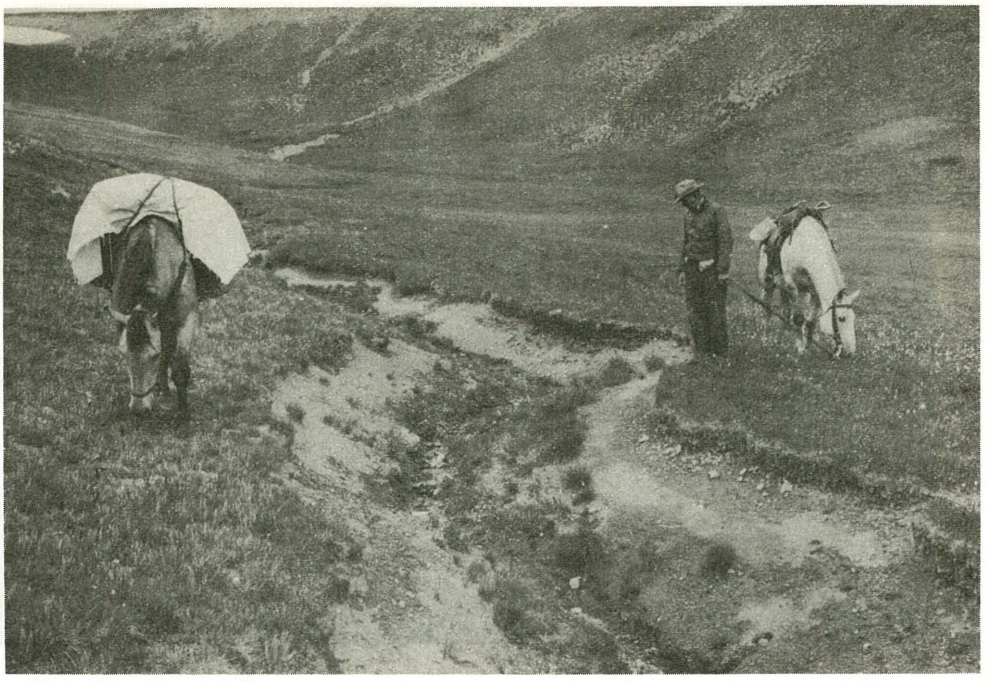
10. Alpine meadow in poor condition. While the surrounding meadow is in good condition, severe erosion lowers the rating. An advanced scalped area in a dense tufted hairgrass stand. Grass clump has slipped down and taken root. Cushion plants are reoccupying the area and show that this is not a snowbank site.



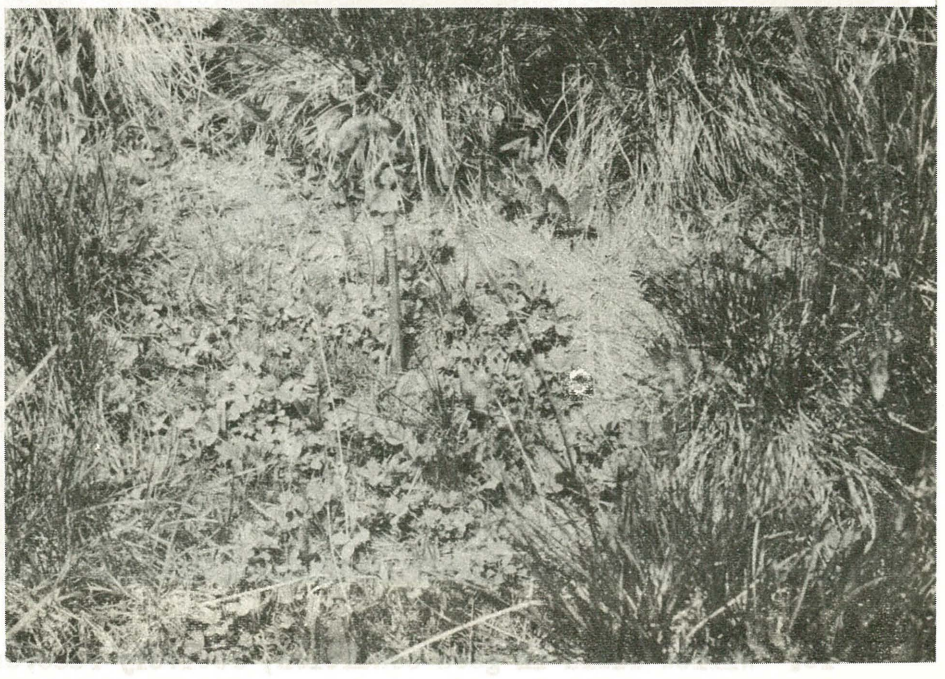
11. Alpine meadow in poor condition. Tufted hairgrass-rush community with very few forbs remaining. Severe pedestalling and sod breaks. Ragged sod edges above and to right illustrate snowbank trailing although most of this area remains virtually bare because snow persists to mid-summer.



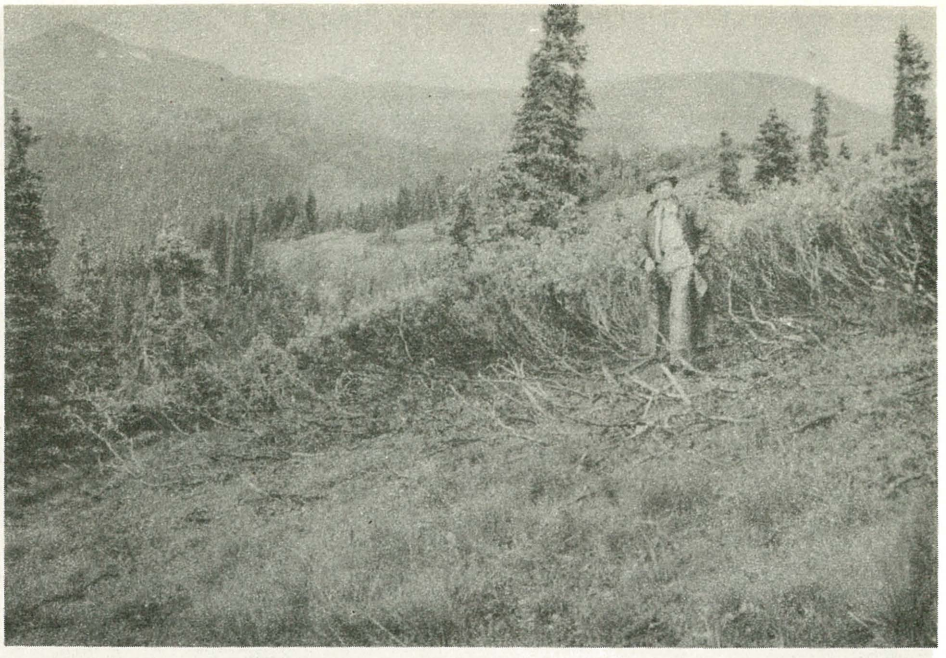
12. Alpine meadow in poor condition because of sod breaks and scalped areas (background) resulting from trailing and inadequate range. Tufted hairgrass-rush community with very few forbs.



13. Alpine meadow, poor condition, because of eroded gully head resulting from sheep trampling. Patches of sod sloughed into gully do not indicate recovery. Uncompahgre National Forest.



14. Alpine meadow. Bare area in tufted hairgrass being invaded by sibbaldia, mountain dandelion, and ligusticella, in this case indicating recovery.



15. Willow stand opened by severe sheep grazing. This represents beginning of extensive willow kills and if unchecked will result in disappearance of willows. Poor condition as indicated by willows and open, trailed herbaceous cover in foreground.

16. Willow field in good condition, actively recovering. Dead stems result from former overgrazing. New shoots have reestablished the normal, rounded edge of willow field. The condition of hairgrass, arnica, rushes, and tufted clovers in foreground is considered in the rating.

17. Isolated willow clump, killed by continued heavy use and replaced by sedges and tufted hairgrass. Alpine meadow.

18. Lower edge of subalpine zone, Mt. Evans. Such alpine plants as alpine sedges, alpine bluegrass, alpine sagebrush, mixed with low-altitude plants as currant, common juniper, wheatgrass, brome, and some typical subalpine plants as bog birch, and phacelia.

19. Cattle grazing on alpine willow fields. Willow stand opened and being converted into an alpine meadow. Such high altitude ranges are better suited for sheep grazing. San Isabel National Forest.

20. Large bog in subalpine zone. Dense sod of tall sedges, colonies of elephanthead pedicularis, marsh marigold, some willows on saturated peat. Too wet and soft for sheep grazing. Rio Grande National Forest.

COMMON CHARACTERISTIC PLANTS

OF THE ROCKY MOUNTAIN ALPINE TYPE

(Those which commonly are cushion plants are marked*)

Pteridophytes

Isoetes bollanderi	Bollander quillwort

Grasses

Agropyron latiglume	Subalpine wheatgrass
A. scribneri	Scribner wheatgrass
Agrostis humilis	Alpine bentgrass
A. idadoensis	Idaho bentgrass
A. thurberiana	Thurber bentgrass
A. variabilis (A. rossae)#	Ross bentgrass
Alopecurus aequalis	Shortawn foxtail
A. alpinus	Alpine foxtail
Avena mortoniana ##	Alpine oatgrass
Danthonia intermedia	Timber danthonia
Deschampsia caespitosa	Tufted hairgrass
Festuca ovina	Sheep fescue
Festuca ovina brachyphylla	Alpine fescue
F. thurberi	Thurber fescue
Phleum alpinum	Alpine timothy
Poa alpina	Alpine bluegrass
P. arctica	Arctic bluegrass
P. glaucifolia	Blueleaf bluegrass
P. interior	Inland bluegrass
P. leptocoma	Bog bluegrass
P. lettermani	Letterman bluegrass
P. pattersoni	Patterson bluegrass
P. rupicola	Timberline bluegrass
Stipa columbiana	Subalpine needlegrass
S. lettermani	Letterman needlegrass
Trisetum montanum	Rocky Mt. trisetum
T. spicatum	Spike trisetum

Grass-like Plants

Carex albonigra	Black and white sedge
C. arapahoensis	Arapaho sedge
C. atrata	Black sedge
C. bella	----------
C. chalciolepis	----------
C. chimaphila	----------
C. drummondiana	Drummond sedge
C. elynoides	----------
C. haydeniana	Hayden sedge

Some widely used synonyms are shown in parenthesis

Helictotrichon mortonianum, Manual Grasses of U.S. 2d Ed.

C. illota	Sheep sedge
C. nigricans	Black Alpine sedge
C. nova	Little sedge
C. nubicola	Cloud sedge
C. physocarpa	----------
C. podocarpa	----------
C. pseudoscirpoidea	False bulrush sedge
C. pyrenaica	Pyrennees sedge
C. vernacula	----------
Eriophorum angustifolium	Narrowleaf cottonsedge
E. chamissonia	----------
Juncus drummondi	Drummond rush
J. parryi	Parry rush
Kobresia bellardi (Elyna bellardi)	Kobresia
Luzula spicata	Spike woodrush

Forbs

Achillea lanulosa alpicola	Subalpine yarrow
Actinea acaulis	Stemless actinea
A. acaulis lanigera (Actinella lanata)	Wooly stemless actinea
Actinea grandiflora (Rydbergia grandiflora)	Graylocks actinea
A. brandegei	Brandegee actinea
Agoseris aurantiaca	Orange agoseris
Androsace carinata* (Drosace carinata)	Rockjasmine
A. septentrionalis*	Rockjasmine
Anemone zephyra (A. narcissiflora)	Narcissus anemone
Antennaria microphylla*	Littleleaf pussytoes
A. rosea*	Rose pussytoes
A. sedoides*	----------
Aquilegia saximontana	Rocky Mtn. columbine
Arabis drummondi	Drummond rockcress
Arabis lyalli	Lyall rockcress
Arenaria macrantha	----------
A. obtusiloba	Mat sandwort
A. sajanensis*	Siberian sandwort
A. verna pubescens*	Tufted sandwort
Arnica mollis	Hairy arnica
A. rydbergi	Rydberg arnica
Artemisia scopulorum	Alpine sagebrush
Aster coloradensis	Colorado aster
A. haydeni (A. alpigenus)	Hayden aster
Caltha leptosepala	Elkslip marshmarigold
C. petiolata	American harebell
Castilleja rhexifolia	Splitleaf paintedcup
C. haydeni	Hayden paintedcup
C. occidentalis	Western paintedcup
Cerastium alpinum*	Alpine cerastium (chickweed)
C. pulchellum*	Beauty cerastium
Chaenactis alpina	Alpine chaenactis
C. douglasii	Douglas chaenactis
Chionophila jamesi	James snowlover

Cirsium drummondi acaulescens	Birdsnest thistle
C. pallidum	Hoary thistle
C. scopulorum	Lion's head thistle
Claytonia megarrhiza	Alpine springbeauty
Delphinium barbeyi	Barbey larkspur
Douglasia montana*	Mountain douglasia
Draba oligosperma* (D. andina)	Draba
D. crassifolia var. typica*	Draba
D. fladnizensis*	Arctic draba
D. spectabilis*	Showy draba
Epilobium alpinum	Alpine willowweed
E. clavatum	----------
E. latifolium	Red willowweed
Erigeron melanocephalus	Black-headed fleabane
E. pinnatispectus	Pinnate fleabane
E. simplex* (E. uniflorus)	One-flower fleabane
E. vagus	Woolly fleabane
Eriogonum flavum*	Yellow eriogonum
E. subalpinum*	Subalpine eriogonum
Eritrichum elongatum var. argenteum*	Alpine-forgetmenot
E. nanum*	Small alpine-forgetmenot
Gentiana fremonti	Fremont gentian
G. parryi	Parry gentian
G. prostrata	Prostrate gentian
G. romanzovi	Romanzoff gentian
Geum rossi	Golden avens
H. parvifolia	Littleleaf alumroot
Lewisia pygmaea	Least lewisia
Ligusticella eastwoodae	Ligusticella
Lloydia serrotina	Alplily
Lychnis apetala	Mountain Campion
Mertensia alpina	Alpine bluebells
Oreoxis alpina (Cymopterus alpinus)	Alpine oreoxis
Oxyria digyna	Alpine mountainsorrel
Oxytropis (several species)	Crazyweed ½ (loco)
Paronychia pulvinata	Rocky Mountain nailwort
Pedicularis groenlandica	Elephanthead
P. scopulorum	Rocky Mtn. pedicularis
Penstemon halli	Halls penstemon
P. harbouri	Harbours penstemon
P. retrorsus	----------
P. whippleanus	Whipple penstemon
Phacelia sericea	Silky phacelia
Phlox caespitosa pulvinata*	Tufted phlox
P. caespitosa condensata*	Dwarf tufted phlox
Polemonium brandegei	Brandegee polemonium
P. confertum	Skypilot polemonium
P. delicatum scopulinum	Cliff polemonium
P. grayianum	Grays polemonium
Polygonum bistortoides	American bistort
P. viviparum	Viviparous bistort
Potentilla concinna	Elegant cinquefoil
P. quinquefolia*	----------

P. pulcherrima	Beauty cinquefoil
Primula angustifolia	Colorado primrose (Fairy primrose)
P. parryi	Parry primrose
Ranunculus adoneus	Alpine buttercup (Snow buttercup)
R. macauleyi	Macauley buttercup
Sagina saginoides	Arctic pearlwort
Saxifraga bronchialis*	Saxifrage
S. caespitosa*	Mat saxifrage
S. cernua	---
S. chrysantha	Goldenbloom saxifrage
S. flagellaris*	Creeping saxifrage
S. richardsoni*	Richardson saxifrage
Sedum integrifolium (Rhodiola integrifolia)	Kingscrown stonecrop
S. rhodanthum (Clementsia rhodantha)	Queenscrown stonecrop (Rosecrown)
Senecio amplectens	Showy alpine groundsel
S. atratus	Black groundsel
S. bigelovi	Bigelow groundsel
S. crocatus	Saffron groundsel
S. soldanella	Alpenglock groundsel
S. taraxicoides	Dwarf groundsel
Sibbaldia procumbens	Sibbaldia (falsestrawberry)
Silene acaulis*	Moss silene
Stellaria alpestris	Alpine starwort
S. crassifolia	---
S. longipes laeta	Longstalk starwort
S. polygonoides	---
Swertia perennis	Alpinebog swertia
Synthyris alpina	Alpine kittentails
Thalictrum alpinum	Alpine meadowrue
Thlaspi alpestris (T. coloradense and T. glaucum*)	Mountain pennycress
Trifolium anemophilum#	Wyoming clover
T. attenuatum*	Mountain clover
T. bracteolalum#	---
T. brandegei	Brandegee clover
T. dasyphyllum*	Whiproot clover
T. lividum#	---
T. nanum*	Dwarf clover
T. parryi	Parry clover
T. stenolobum	Thrift clover
Trollius laxus var. albiflorus	American globeflower
Veronica wormskjoldi	Speedwell
Viola adunca	Hook violet
V. biflora	Twinflower violet
V. canadensis var. scopulorum	Canada violet

Shrubs

Dryas octopetala	Mt. Washington dryad
Kalmia polifolia	Bog kalmia

#These three species are regarded by some authorities as part of the T. dasyphyllum complex.

Phyllodoce empetriformis	Red mountainheath
Potentilla fruticosa (Dasiphora fruticosa)	Shrubby cinquefoil
Salix brachycarpa	Barrenground willow
S. cascadensis	Cascades willow
S. glauca and vars.	Grayleaf willow
S. nivalis	Snow willow
S. petrophila	Skyland willow
S. planifolia (S. chlorophylla)	Planeleaf willow
S. planifolia var. nelsoni	Nelson planeleaf willow
S. pseudolapponum	False Lapland willow
S. saximontana	Summit willow
S. wolfi	Wolf's willow
Vaccinium myrtillus	Myrtle whortleberry

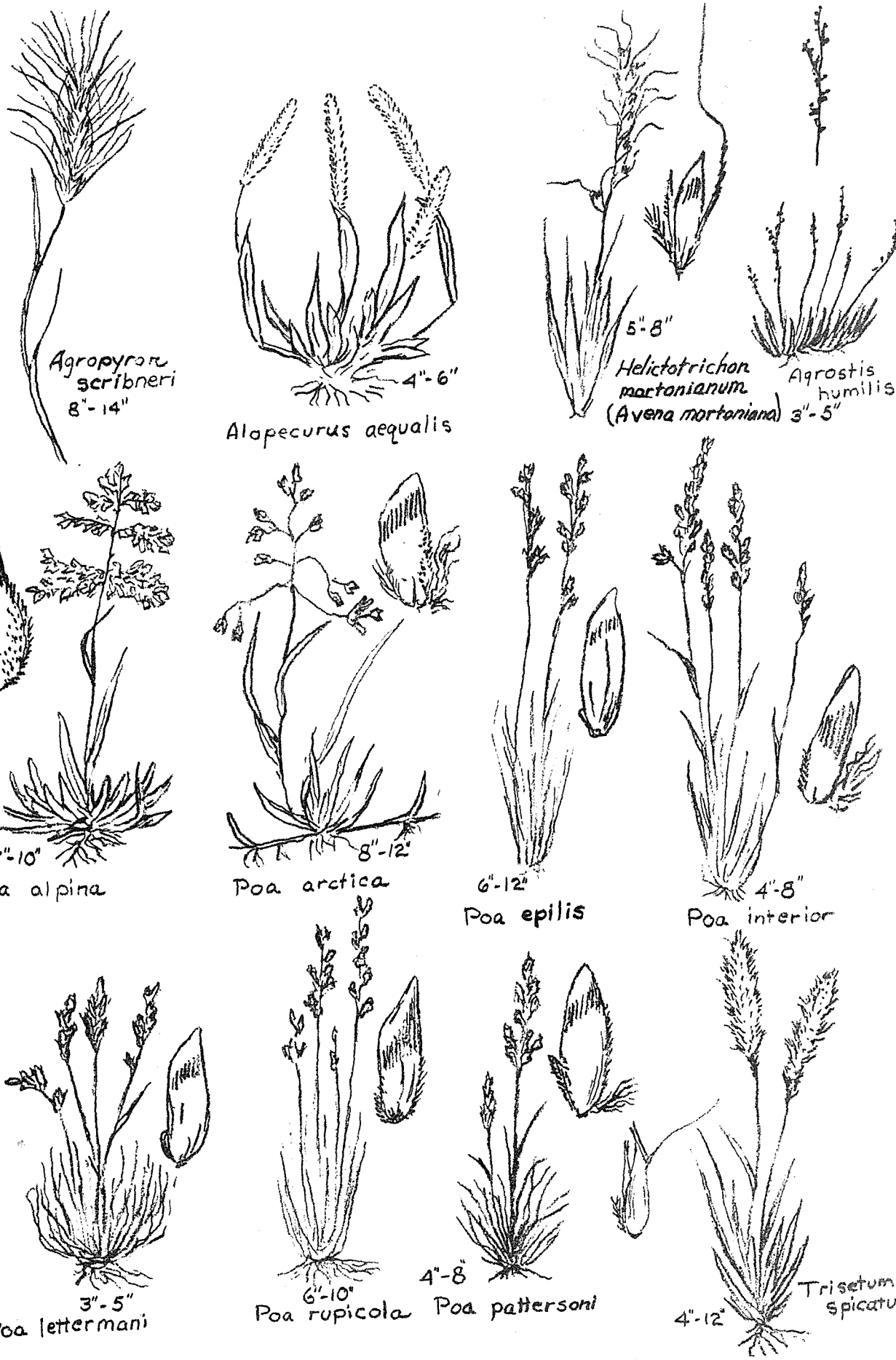


PLATE 1.

GPO 82-9000204

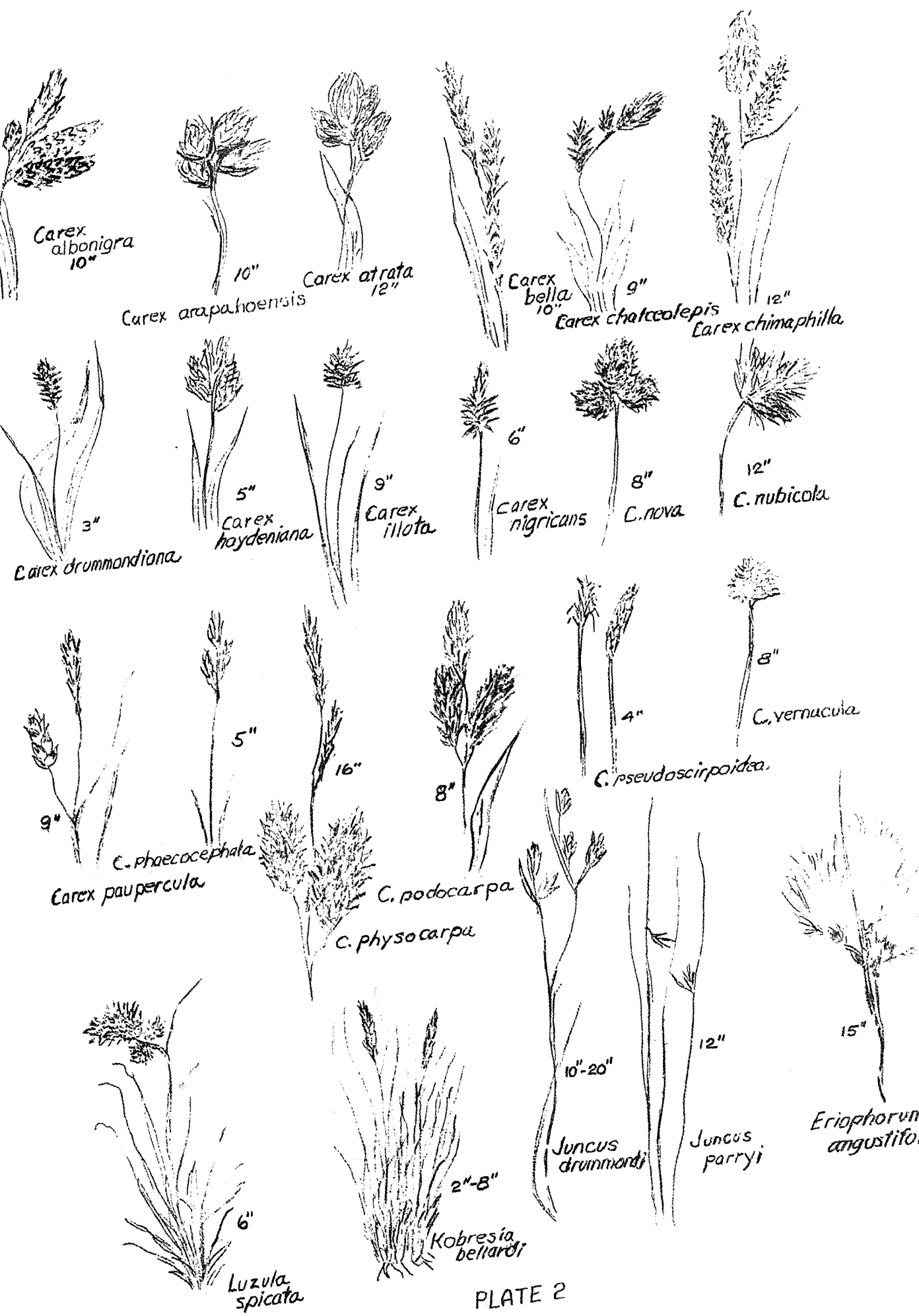

Carex albonigra
10"
10"
Carex atrata
12"
Carex arapahoensis
Carex bella
10"
9"
Carex chalcolepis
12"
Carex chimaphilla
3"
Carex drummondiana
5"
Carex haydeniana
9"
Carex illota
6"
carex nigricans
8"
C. nova
12"
C. nubicola
9"
C. phaeocephala
Carex paupercula
5"
16"
C. physocarpa
8"
C. podocarpa
4"
C. pseudoscirpoidea
8"
C. vernucula
6"
Luzula spicata
2"-8"
Kobresia bellardi
10"-20"
Juncus drummondi
12"
Juncus parryi
15"
Eriophorum angustifo

PLATE 2

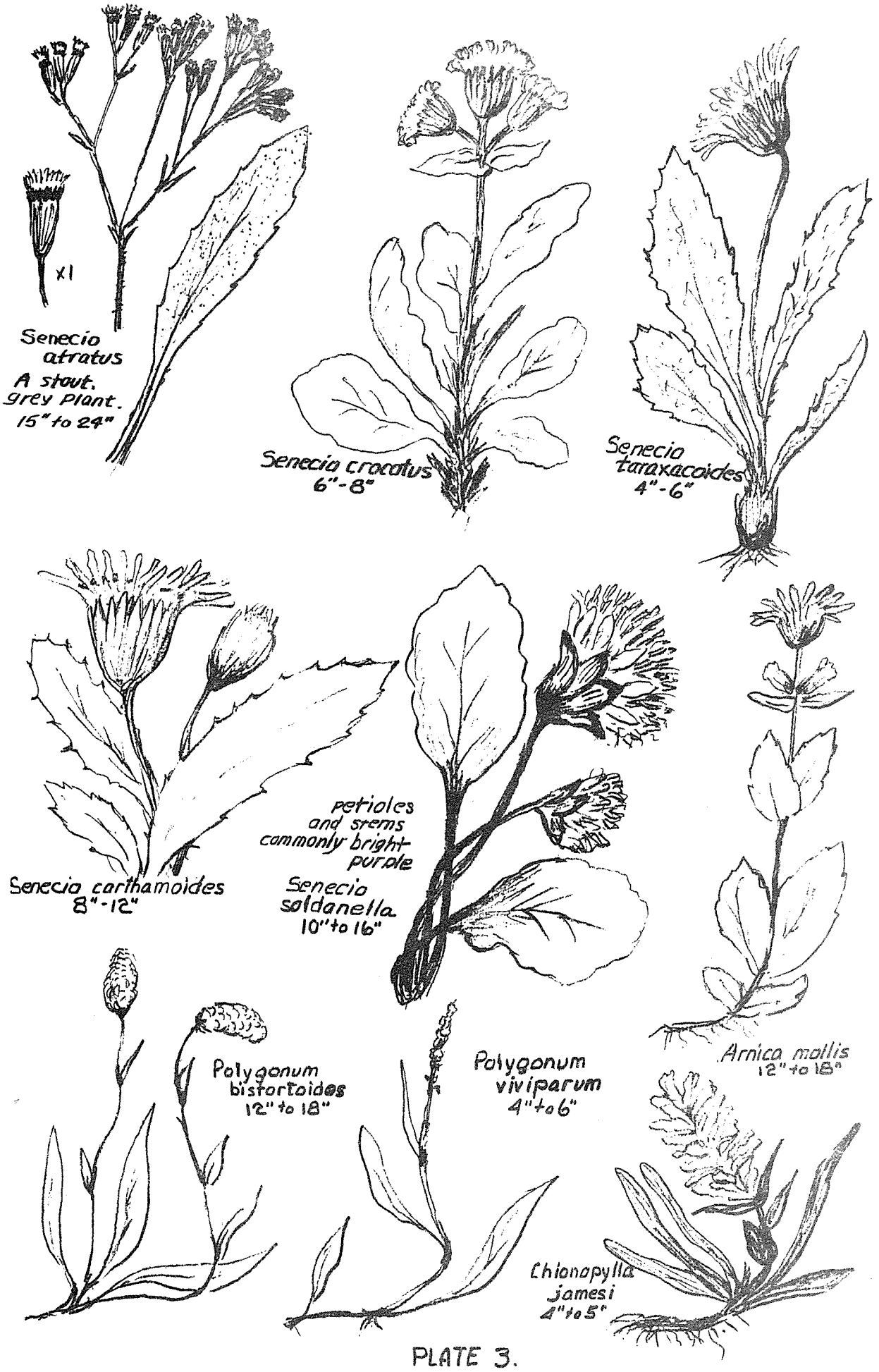
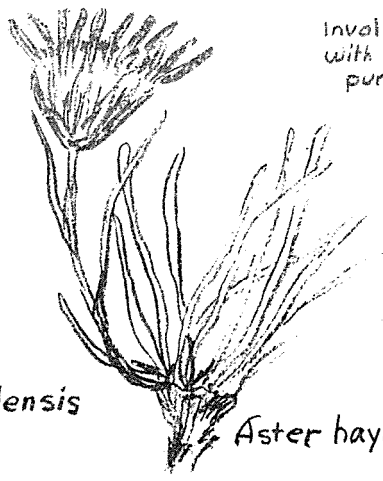
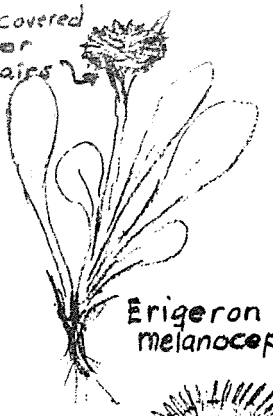

x1
Senecio atratus
A stout, grey plant.
15" to 24"
Senecio crocatus
6"-8"
Senecio taraxacoides
4"-6"
Senecio carthamoides
8"-12"
petioles and stems commonly bright purple
Senecio soldanella
10" to 16"
Arnica mollis
12" to 18"
Polygonum bistortoides
12" to 18"
Polygonum viviparum
4" to 6"
Chionopylla jamesi
4" to 5"

PLATE 3.

Aster coloradensis

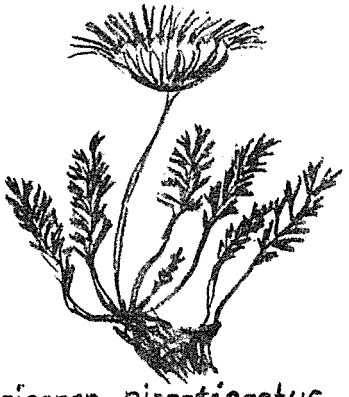


Aster haydeni



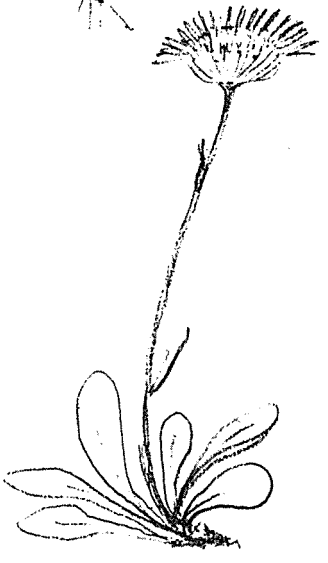
Involucre covered with black or purple hairs

Erigeron melanocephalus



Erigeron pinnatisectus

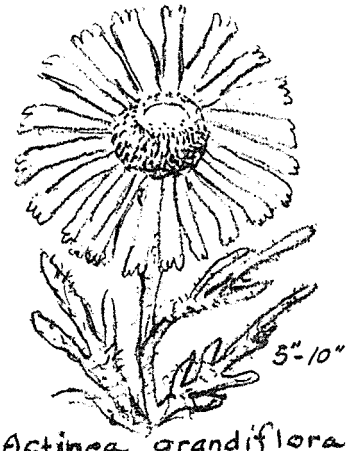
Erigeron vagus



Erigeron simplex (E. uniflorus)

Chaenactis alpina

Actinea acaulis lanigera



5"-10"

Actinea grandiflora

Epilobium clavatum

Epilobium anagallidifolium

Pedicularis scopulorum 4"-7"

Penstemon Whippleanus 10-15"

PLATE 4

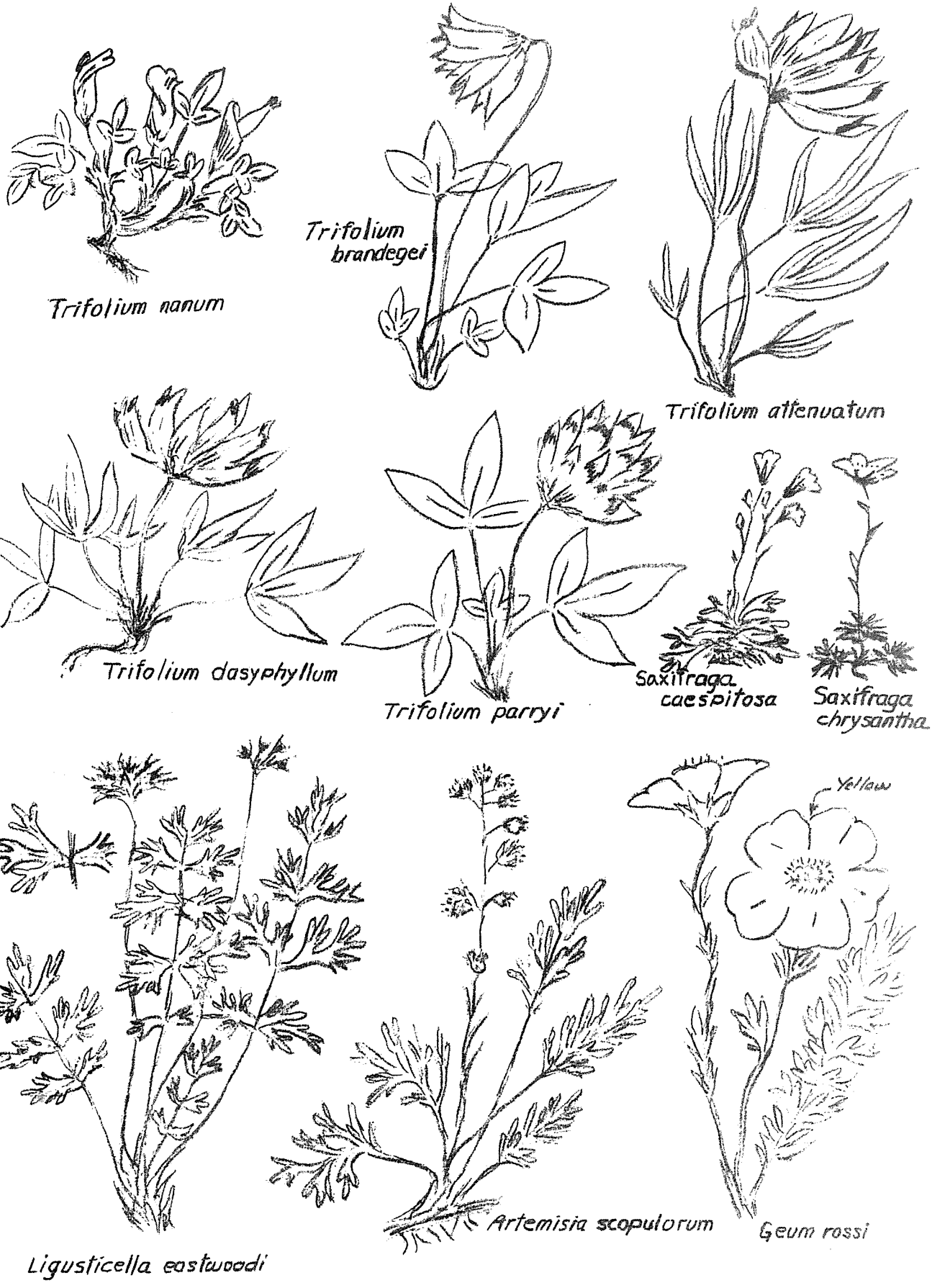

Trifolium nanum
Trifolium brandegei
Trifolium attenuatum
Trifolium dasyphyllum
Trifolium parryi
Saxifraga caespitosa
Saxifraga chrysantha
Yellow
Ligusticella eastwoodi
Artemisia scopulorum
Geum rossi

PLATE 5

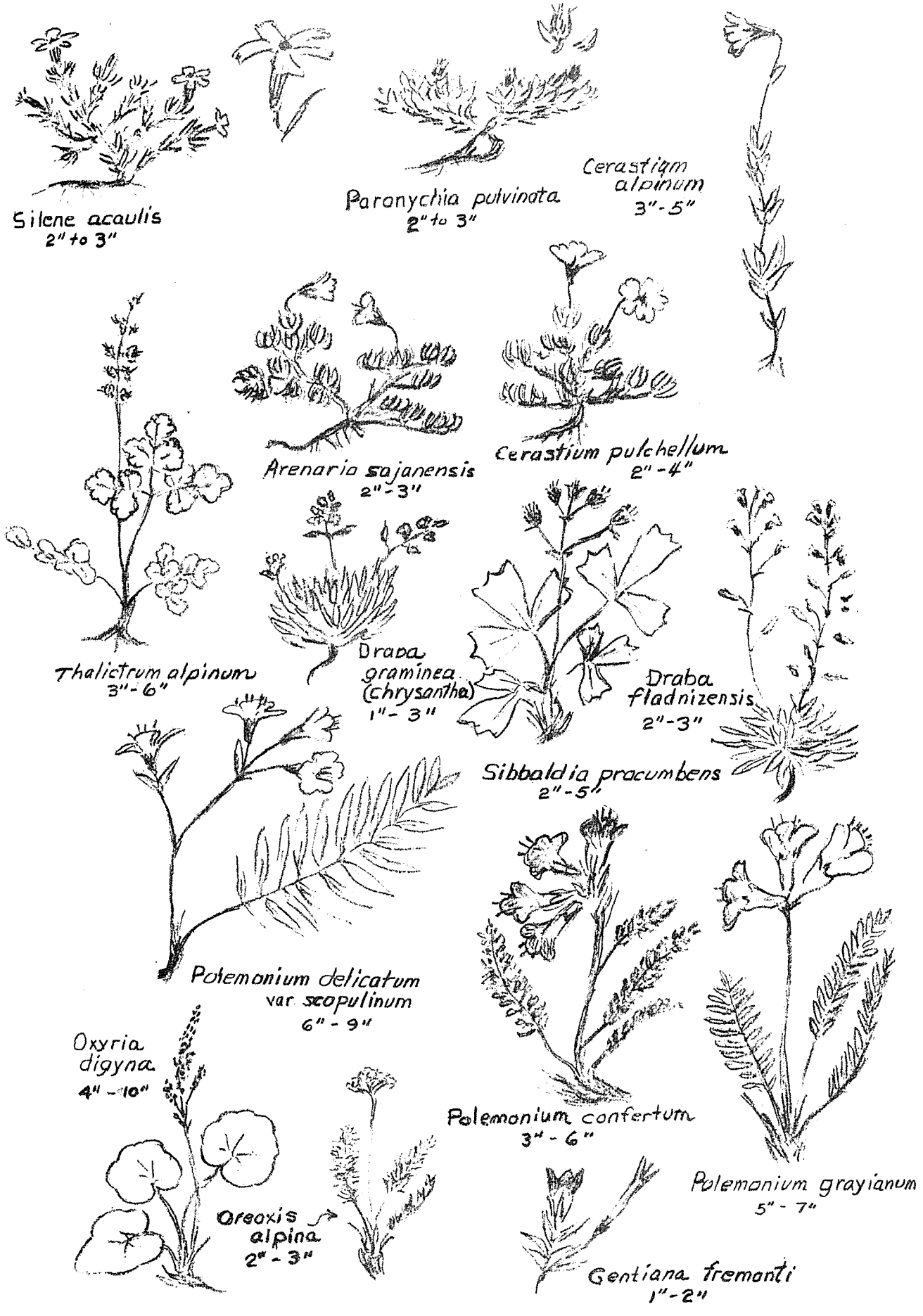

Silene acaulis
2" to 3"
Paronychia pulvinata
2" to 3"
Cerastium alpinum
3"-5"
Arenaria sajanensis
2"-3"
Cerastium pulchellum
2"-4"
Thalictrum alpinum
3"-6"
Draba graminea (chrysantha)
1"-3"
Draba fladnizensis
2"-3"
Sibbaldia procumbens
2"-5"
Polemonium delicatum
var scopulinum
6"-9"
Oxyria digyna
4"-10"
Oreoxis alpina
2"-3"
Polemonium confertum
3"-6"
Polemonium grayianum
5"-7"
Gentiana fremonti
1"-2"

PLATE 6.